

IN THE CLAIMS

The following is a complete listing of the claims, and replaces all earlier versions and listings.

1. (Currently Amended) A method of encoding a sequence of images for transmission over a communication network, said method comprising the steps of:
 - (i) rendering ~~[[on]]~~ a first image from an ~~[[a]]~~ object-based computer graphics application;
 - (ii) encoding ~~[[said]]~~ the first image according to a predetermined encoding scheme;
 - (iii) rendering ~~[[an]]~~ a second image from ~~[[said]]~~ the object-based computer graphics application;
 - (iv) identifying changes between ~~[[said]]~~ the first image and ~~[[said]]~~ the second image from a change indicating output of ~~[[said]]~~ the computer graphics application;
 - (v) using ~~[[said]]~~ the identified changes to determine a manner in which ~~[[said]]~~ the second image is encoded according to ~~[[said]]~~ the predetermined encoding scheme format; and
 - (vi) repeating steps (iii) to (v) for each subsequent image of ~~[[said]]~~ the sequence.

2. (Currently Amended) A method according to claim 1, wherein the computer graphics application outputs a pixel-based representation of each the image to a buffer, and said encoding, at least for the first image, operates upon the pixel-based representation and for the second and subsequent images upon at least the change indicating output.

3. (Currently Amended) A method according to claim 2, wherein the change indicating output comprises information indicating an extent of change in the pixel-based representation in said buffer thereby enabling said encoding according to the predetermined encoding scheme of substantially only those pixels that have changed.

4. (Currently Amended) A method according to claim 2, wherein the computer graphics application acts to render a hierarchical representation of each the image and the change indicating output comprises information indicating are extent of change between the images of the corresponding the hierarchical representations.

5. (Currently Amended) A method according to claim 1, wherein the predetermined encoding scheme comprises MPEG encoding and said encoding forms, for each the image, a data stream for transmission over the network.

6. and 7. (Canceled)

8. (Currently Amended) An encoder for encoding a series of images into a bitstream, each ~~[[said]]~~ image being rendered from a graphics object application, ~~characterised in that~~ which said encoder is constrained to operate according to a plurality of inputs describing the image, ~~where~~ wherein the format of ~~[[said]]~~ the inputs is known by ~~[[the]]~~ said encoder.

9. (Currently Amended) An encoder according to claim 8, wherein one of ~~[[said]]~~ the inputs comprises a first change input representing ~~those~~ portions of a pixel map of a current ~~[[said]]~~ image that have changed relative to an immediately preceding image in said series.

10. (Currently Amended) An encoder according to claim 8, wherein an input to ~~[[said]]~~ the graphical object application comprises a hierarchical representation of ~~[[said]]~~ the image and one of ~~[[said]]~~ the inputs comprises a second change input representing ~~those~~ portions of ~~[[said]]~~ the hierarchical representation of a current ~~[[said]]~~ image that have changed relative to an immediately preceding image in ~~[[said]]~~ the series.

11. - 15. (Canceled)

16. (Currently Amended) A method of forming a sequence of images for transmission over a communication network, said method comprising the steps of:

forming representations of plural graphical object-based images;

rendering ~~[[said]]~~ the images in a sequence using a computer graphics application, said rendering comprising:

determining a set of changes required to transform a previous image in ~~[[said]]~~ the sequence into a current image in ~~[[said]]~~ the sequence, and ~~[[;]]~~

indicating ~~[[said]]~~ the changes in a format known to an encoder a priori; and

encoding ~~[[said]]~~ the sequence using said encoder such that said encoder ~~utilises~~ utilizes at least one of ~~[[said]]~~ the changes to ~~optimise~~ optimize encoding of ~~[[said]]~~ the current image.

17. (Currently Amended) A method according to claim 16, wherein ~~[[said]]~~ the representations comprise at least one hierarchical compositing tree.

18. (Currently Amended) A method according to claim 16, wherein ~~[[said]]~~ the at least one of ~~[[said]]~~ the changes is other than a pixel map representation of ~~[[said]]~~ the current image.

19. (Currently Amended) A method according to claim 18, wherein one [[said]] change comprises information related to a transformation matrix of changed regions in [[said]] the current image.

20. (Currently Amended) A method according to claim 18, wherein one [[said]] change comprises information regarding content of [[said]] the current image.

21. (Currently Amended) (Currently Amended) A method according to claim 20, wherein said content comprises at least one of plane fill data and [[a]] run-length encoded data used to form [[said]] the current image and [[said]] the information indicates that [[said]] the content forms a region of ~~flat colour~~ plane fill color in [[said]] the current image.

22. (Currently Amended) A method according to claim 21, wherein [[said]] the content further comprises a pixel map of [[said]] the current image.

23. (Currently Amended) A method according to claim 18, wherein one [[said]] change comprises information regarding whether a region of [[said]] the current image is one of a background region or a foreground region.

24. (Currently Amended) A method according to claim 18 wherein one [[said]] change comprises information regarding a position and area of a region of [[said]] the current image that has changed.

25. (Currently Amended) A method according to claim 18, wherein one [[said]] change comprises information regarding changes to [[said]] the compositing tree.

26. (Currently Amended) A method according to claim 21, wherein, when [[said]] the content comprises a plane fill, said encoding comprises a single ~~colour~~ color conversion operation and encoding of a single pixel value for [[said]] the current image.

27. (Currently Amended) A method according to claim 21, wherein, when [[said]] the content comprises run-length data, said encoding comprises, for each run of data in [[said]] the current image, a single color conversion and encoding of a pixel value.

28. (Currently Amended) A method according to claim 16, further comprising storing an encoded representation of at least [[said]] the current image for use in an encoding of a subsequent image in [[said]] the sequence.

29. (Currently Amended) A method according to claim 28, wherein said encoded representation comprises a plurality of separately encoded discrete portions.

30. (Currently Amended) A method according to claim 29, wherein [[said]] the set of changes comprises a change to a [[said]] compositing tree by which the object-based graphical image is described, [[said]] the change indicating a portion of a rendered current image having changed ~~due to motion in the sequence~~, said encoding comprising determining ~~those of said~~ the discrete portions that require update as a result in view of [[said]] the change, encoding rendered pixel values output from [[said]] the computer graphics application corresponding to [[said]] the changes ~~discrete portions~~ as replacement ones of [[said]] the portions, and combining [[said]] the replacement portions with remaining portions of the preceding encoded image to form a current encoded image.

31. (Currently Amended) A method according to claim 29, further comprising, for a first image of a determinable sequence of images, storing an encoded version of [[said]] the first image with a flag identifiable by [[said]] the indicated change such that [[said]] the indicated change allows ~~causes~~ retrieval of [[said]] the stored encoded first image for transmission.

32. (Currently Amended) A method according to claim 31, wherein [[said]] the indicated change for a subsequent rendered image in [[said]] the sequence is compared with ~~said store~~ the stored encoded first image and wherein [[said]] the encoded first image is stored as a plurality of separately encoded portions and [[said]] the indicated change for [[said]] the subsequent rendered image is used ~~is used~~ to encode only ~~those said~~ the portions that have changed.

33. (Currently Amended) A method according to claim 28, wherein if [[said]] the current image is identical to [[said]] the preceding image, said encoding comprises encoding a special image indicator representative of no-change in [[said]] the sequence at [[said]] the current image.

34. (Currently Amended) A method according to claim 33, wherein [[said]] the encoded preceding image comprises a plurality of slices in raster scan order, each formed of plural of [[said]] the discrete portions, [[said]] the indicator being provided for a slice of [[said]] the image, wherein ~~those said~~ the discrete portions that have not changed are encoded within each [[said]] slice using motion vectors set to zero.

35. (Currently Amended) A method according to claim 29, wherein said encoding forms an MPEG representation of each [[said]] image in which [[said]] the discrete portions comprise MPEG macroblocks.

36. (Currently Amended) A method according to claim 35, wherein said encoding forms an MPEG P-frame, said encoding further comprising:

(a) extracting a slice of a rendered image frame, the slice comprising a plurality of the macroblocks;

(b) determining if a first macroblock of [[said]] the extracted slice is dirty and, if so, encoding [[said]] the first macroblock to an output bitstream and

storing a copy of [[said]] the encoded first macroblock in a cache and, if not, copying a pre-encoded macroblock from said cache to [[said]] the output bitstream;

(c) for each further macroblock in [[said]] the slice barring the last, determining if [[said]] the macroblock is dirty and, if so:

(ca) encoding the macroblock to [[said]] the output bitstream, and [[:]]

(cb) storing the encoded macroblock in said cache;

(d) for the last macroblock in [[said]] the slice:

(da) determining if [[said]] the macroblock is dirty, [[:]]

(db) if so, encoding the last macroblock to [[said]] the output bitstream, and [[:]]

(dc) if not, copying a pre-encoded macroblock from said cache to [[said]] the output bitstream; and

(e) repeating steps (a) to (d) for each remaining slice of [[said]] the rendered image frame to thereby form [[said]] the P-frame.

37. (Currently Amended) A method according to claim 35, wherein said encoding forms an MPEG I-frame, said encoding further comprising:

(a) obtaining a macroblock of a rendered image frame;

(b) extracting an unencoded DC value of the previous macroblock from a cache used to store encoded frames;

- (c) determining a difference DC value between the obtained macroblock and the extracted unencoded DC value;
- (d) encoding the difference DC value to an output bitstream;
- (e) copying an encoded AC component from said cache to [[said]] the output bitstream; and
- (f) repeating steps (a) to (e) for each macroblock of [[said]] the rendered image frame to form [[said]] the I-frame.

38. (Currently Amended) A method according to claim 35, wherein said encoding further comprises setting a flag on any macroblock that has previously been marked as dirty and subsequently encoded and upon any previous [[said]] macroblock that has [[said]] the flag set, [[said]] the flag being used to determine whether one of cached bitstream representation of [[said]] the macroblock or a stored encoded bitstream of [[said]] the macroblock is restored to an output bitstream.

39. (Currently Amended) A method according to claim 35, wherein said encoding comprises, for each [[said]] macroblock:

- (a) storing a DC component for [[said]] the macroblock;
- (b) storing a reference from [[said]] the macroblock to an immediately preceding macroblock;
- (c) DCT transforming, ~~quantising~~ quantizing and storing an AC component of [[said]] the macroblock; and

(d) storing a flag to mark ~~[[said]]~~ the macroblock as either dirty or non-dirty.

40. (Currently Amended) A method according to claim 39, further comprising, for each macroblock that is marked as dirty, the steps of:

- (i) applying a DCT;
- (ii) calculating and saving the DC delta;
- (iii) ~~quantising~~ quantizing the macroblock;
- (iv) saving the DC component of ~~[[said]]~~ the macroblock;
- (v) encoding the macroblock using bit stream encoding;
- (vi) saving the bitstream encoded macroblock; and
- (vii) setting the dirty flag to not dirty.

41. (Currently Amended) A method according to claim 39, further comprising, for each macroblock that is marked as non-dirty, and is not preceded by dirty macroblocks since the start of a current slice, restoring the macroblock from a bitstream encoded version thereof.

42. (Currently Amended) A method according to claim 39, further comprising, for each macroblock that is not marked as dirty, but preceded by a macroblock marked as dirty since the start of a current slice, the steps of:

- (i) restoring the cached DC values;

- (ii) calculating the DC delta;
- (iii) ~~quantising~~ quantizing the DC portion of the macroblock;
- (iv) encoding the macroblock using bit stream encoding; and
- (v) saving the bitstream encoded macroblock

43. (Currently Amended) A computer readable medium having recorded thereon a computer program for forming a sequence of images for transmission over a communication network, said program comprising:

code for forming representations of plural graphical object-based images;

code for rendering ~~[[said]]~~ the images in a sequence using a computer graphics application, said code for rendering including:

code for determining a set of changes required to transform a previous image in ~~[[said]]~~ the sequence into a current image in ~~[[said]]~~ the sequence, and ~~[[;]]~~

code for indicating ~~[[said]]~~ the changes in a format known to an encoder *a priori*; and

code for encoding ~~[[said]]~~ the sequence using said encoder such that said encoder ~~utilises~~ utilizes at least one of ~~[[said]]~~ the changes to ~~optimise~~ optimize encoding of ~~[[said]]~~ the current image.

44. (Currently Amended) A computer readable medium according to claim 43, wherein [[said]] the representations comprise at least one hierarchical compositing tree.

45. (Currently Amended) A computer readable medium according to claim 43, wherein [[said]] the at least one of [[said]] the changes is other than a pixel map representation of [[said]] the current image.

46. (Currently Amended) A computer readable medium according to claim 45, wherein one [[said]] change comprises information related to a transformation matrix of changed regions in [[said]] the current image.

47. (Currently Amended) A computer readable medium according to claim 45, wherein one [[said]] change comprises information regarding content of [[said]] the current image.

48. (Currently Amended) A computer readable medium according to claim 47, wherein [[said]] the content comprises at least one of plane fill data and [[a]] run-length encoded data used to form [[said]] the current image and [[said]] the information indicates that [[said]] the content forms a region of ~~flat colour~~ plane fill color in [[said]] the current image.

49. (Currently Amended) A computer readable medium according to claim 48, wherein [[said]] the content further comprises a pixel map of [[said]] the current image.

50. (Currently Amended) A computer readable medium according to claim 45, wherein one [[said]] change comprises information regarding whether a region of [[said]] the current image is one of a background region or a foreground region.

51. (Currently Amended) A computer readable medium according to claim 45, wherein one [[said]] change comprises information regarding a position and area of a region of [[said]] the current image that has changed.

52. (Currently Amended) A computer readable medium according to claim 45, wherein one [[said]] change comprises information regarding changes to [[said]] the compositing tree.

53. (Currently Amended) A computer readable according to claim 45, wherein, when [[said]] the content comprises a plane fill, said encoding comprises a single ~~colour~~ color conversion operation and encoding of a single pixel value for [[said]] the current image.

54. (Currently Amended) A computer readable medium according to claim 48, wherein, when [[said]] the content comprises run-length data, said encoding

comprises, for each run of data in ~~[[said]]~~ the current image, a single conversion and encoding of a pixel value.

55. (Currently Amended) A computer readable medium according to claim 43, further comprising code for storing an encoded representation of at least ~~[[said]]~~ the current image for use in an encoding of a subsequent image in ~~[[said]]~~ the sequence.

56. (Currently Amended) A computer readable medium according to claim 55, wherein ~~[[said]]~~ the encoded representation comprises a plurality of separately encoded discrete portions.

57. (Currently Amended) A computer readable medium according to claim 56, wherein ~~[[said]]~~ the set of changes comprises a change to a ~~[[said]]~~ compositing tree ~~by which the object-based graphical image is described,~~ ~~[[said]]~~ the change indicating a portion of a rendered current image having changed ~~due to motion in the sequence,~~ said code for encoding comprising code for determining ~~those of said~~ the discrete portions that require update ~~as a result in view~~ of ~~[[said]]~~ the change, code for encoding rendered pixel values output from ~~[[said]]~~ the computer graphics application corresponding to ~~[[said]]~~ the changes ~~discrete portions~~ as replacement ones of ~~[[said]]~~ the portions, and code for combining ~~[[said]]~~ the replacement portions with remaining portions of the preceding encoded image to form a current encoded image.

58. (Currently Amended) A computer readable medium according to claim 56, further comprising, for a first image of a determinable sequence of images, code for storing an encoded version of ~~[[said]]~~ the first image with a flag identifiable by ~~[[said]]~~ the indicated change such that ~~[[said]]~~ the indicated change allows ~~causes~~ retrieval of ~~[[said]]~~ the stored encoded first image for transmission.

59. (Currently Amended) A computer readable medium according to claim 58, wherein ~~[[said]]~~ the indicated change for a subsequent rendered image in ~~[[said]]~~ the sequence is compared with ~~said-store~~ the stored encoded first image and wherein ~~[[said]]~~ the encoded first image is stored as a plurality of separately encoded portions and ~~[[said]]~~ the indicated change for ~~[[said]]~~ the subsequent rendered image is used to encode only ~~those said~~ the portions that have changed.

60. (Currently Amended) A computer readable medium according to claim 55, wherein, if ~~[[said]]~~ the current image is identical to ~~[[said]]~~ the preceding image, said code for encoding is operative to encode a special image indicator representative of no-change in ~~[[said]]~~ the sequence at ~~[[said]]~~ the current image.

61. (Currently Amended) A computer readable medium according to claim 60, wherein ~~[[said]]~~ the encoded preceding image comprises a plurality of slices in raster scan order, each formed of plural of ~~[[said]]~~ the discrete portions, ~~[[said]]~~ the indicator being provided for a slice of ~~[[said]]~~ the image, wherein ~~those said~~ the discrete portions

that have not changed are encoded within each [[said]] slice using motion vectors set to zero.

62. (Currently Amended) A computer readable medium according to claim 56, wherein said encoding forms an MPEG representation of each [[said]] image in which [[said]] the discrete portions comprise MPEG macroblocks.

63. (Currently Amended) A computer readable medium according to claim 62, wherein said encoding forms an MPEG P-frame, said encoding further comprising:

- (a) extracting a slice of a rendered image frame, the slice comprising a plurality of the macroblocks;
- (b) determining if a first macroblock of [[said]] the extracted slice is dirty and, if so, encoding [[said]] the first macroblock to an output bitstream and storing a copy of [[said]] the encoded first macroblock in a cache and, if not, copying a pre-encoded macroblock from said cache to [[said]] the output bitstream;
- (c) for each further macroblock in [[said]] the slice barring the last, determining if [[said]] the macroblock is dirty and, if so:
 - (ca) encoding the macroblock to [[said]] the output bitstream, and [[:]]
 - (cb) storing the encoded macroblock in said cache;
 - (d) for the last macroblock in [[said]] the slice:
 - (da) determining if [[said]] the macroblock is dirty, [[:]]

(db) if so, encoding the last macroblock to [[said]] the output bitstream, and [[:]]

(dc) if not, copying a pre-encoded macroblock from said cache to [[said]] the output bitstream; and

(e) repeating steps (a) to (d) for each remaining slice of [[said]] the rendered image frame to thereby form [[said]] the P-frame.

64. (Currently Amended) A computer readable medium according to claim 62, [[61]] wherein said encoding forms an MPEG 1-frame, said encoding further comprising:

- (a) obtaining a macroblock of a rendered image frame;
- (b) extracting an unencoded DC value of the previous macroblock from a cache used to store encoded frames;
- (c) determining a difference DC value between the obtained macroblock and the extracted unencoded DC value;
- (d) encoding the difference DC value to an output bitstream;
- (e) copying an encoded AC component from said cache to said output bitstream; and
- (f) repeating steps (a) to (e) for each macroblock of [[said]] the rendered image frame to form [[said]] the I-frame.

65. (Currently Amended) A computer readable medium according to claim 62, [[61]] wherein said encoding further comprises setting a flag on any macroblock that has previously been marked as dirty and subsequently encoded and upon any previous [[said]] macroblock that has [[said]] the flag set, [[said]] the flag being used to determine whether one of cached bitstream representation of [[said]] the macroblock or a stored encoded bitstream of [[said]] the macroblock is restored to an output bitstream.

66. (Currently Amended) A computer readable medium according to claim 62, [[61]] wherein said encoding comprises, for each [[said]] macroblock:

- (a) storing a DC component for [[said]] the macroblock;
- (b) storing a reference from [[said]] the macroblock to an immediately preceding macroblock;
- (c) DCT transforming, ~~quantising~~ quantizing and storing an AC component of [[said]] the macroblock; and
- (d) storing a flag to mark [[said]] the macroblock as either dirty or non-dirty.

67. (Currently Amended) A computer readable medium according to claim 66, further comprising, for each macroblock that is marked as dirty, the steps of:

- (i) applying a DCT;
- (ii) calculating and saving the DC delta;
- (iii) ~~quantising~~ quantizing the macroblock;

- (iv) saving the DC component of ~~[[said]]~~ the macroblock;
- (v) encoding the macroblock using bit stream encoding;
- (vi) saving the bitstream encoded macroblock; and
- (vii) setting dirty flag to not dirty.

68. (Currently Amended) A computer readable medium according to claim 66, further comprising, for each macroblock that is marked as non-dirty, and is not preceded by dirty macroblocks since the start of a current slice,, code for restoring the macroblock from a bitstream encoded version thereof.

69. (Currently Amended) A computer readable according to claim 66 ~~[[65]]~~, further comprising, for each macroblock that is not marked as dirty, but preceded by a macroblock marked as dirty since the start of a current slice, the steps of.

- (i) restoring the cached DC values;
- (ii) calculating the DC delta;
- (iii) ~~quantising~~ quantizing the DC portion of the macroblock;
- (iv) encoding the macroblock using bit stream encoding; and
- (v) saving the bitstream encoded macroblock.

70. (Currently Amended) Apparatus for forming an encoded ~~[[a]]~~ sequence of images for transmission over a communication network, said apparatus comprising.

a graphics processor, adapted to form ~~for forming~~ representations of plural graphic object-based images;

a renderer, adapted to render ~~for rendering~~ each [[said]] representation in sequence to form each [[said]] image, said renderer determining for a current image in [[said]] the sequence excepting the first, a set of changes necessary to transform an immediately preceding image in [[said]] the sequence into [[said]] the current image; and

an encoder, adapted to receive ~~for receiving~~ each [[said]] rendered current image and corresponding set of changes and ~~for encoding said~~ encode the image as part of [[said]] the sequence into a bitstream for said transmission, said encoder using at least one member of [[said]] the corresponding set of changes to determine a manner in which the current image is encoded.

71. (Currently Amended) Apparatus according to claim 70, wherein [[said]] the representations each comprise a hierarchically-based representation of each [[said]] image.

72. (Currently Amended) Apparatus according to claim 71, wherein [[said]] the hierarchical representations each comprise a compositing tree of graphical objects and graphical operations.

73. (Currently Amended) Apparatus according to claim 70, wherein
[[said]] the at least one member of [[said]] the changes is other than a pixel map
representation of [[said]] the current image.

74. (Currently Amended) Apparatus according to claim 73, wherein one
[[said]] change comprises information related to a transformation matrix of changed
regions in [[said]] the current image.

75. (Currently Amended) Apparatus according to claim 73, wherein one
[[said]] member comprises information regarding content of [[said]] the current image.

76. (Currently Amended) Apparatus according to claim 75, wherein
[[said]] the content is selected from the group consisting of a plane fill and [[a]] run-length
encoded data.

77. (Currently Amended) Apparatus according to claim 76, wherein
[[said]] the content further comprises a pixel map of [[said]] the current image.

78. (Currently Amended) Apparatus according to claim 73, wherein
[[said]] the one member comprises information regarding whether [[said]] the current
image is one of a background image or a foreground image.

79. (Currently Amended) Apparatus according to claim 73, wherein one [[said]] member comprises information regarding a position and area of a region of [[said]] the current image that has changed.

80. (Currently Amended) Apparatus according to claims 73, wherein one [[said]] change comprises information regarding changes to [[said]] the compositing tree.